

Name \_\_\_\_\_

AE Chemistry  
Flame Tests Lab

## Experiment 9: Flame Test

**Purpose:** To determine the color emitted from various metals and to use that information to identify an unknown.

### Introduction:

Chemists began studying colored flames in the 18th century and soon used "flame tests" to distinguish between some elements. Different elements burn with different colored flames. Although some of the flames you will be seeing will appear similar in color, their light can be resolved (separated) with a prism or a spectroscope into distinctly different bands of colors on the electromagnetic spectrum (ROYGBIV). These bands of colors are called **bright line spectra**, and they are **UNIQUE** to each element. Niels Bohr studied the line spectrum for hydrogen, and wondered what the specific line spectrum had to do with the structure of the atom. He postulated that an electron can have only specific energy values in an atom, which are called **energy levels**. Bohr believed that the energy levels for electrons were **quantized**, meaning that only certain, specific energy levels were possible. How does an electron move between energy levels? By gaining the right amount of energy, an electron can move, or undergo a transition, from one energy level to the next. An electron in a high energy level (excited state) falls back down to a low energy level (ground state). When this happens, the electron loses energy, which is emitted as a photon of light. The energy difference between the high energy level and the low energy level is related to the frequency (color) of the emitted light.

In this lab today you will "flame"

### Safety:

Take the necessary precautions before beginning this experiment. Wear safety goggles. Read all safety cautions in your procedures. It is important to use good safety techniques while conducting experiments.

### Materials:

4 X 3 well plate		0.5 M Potassium nitrate	(KNO <sub>3</sub> )
6.0 M Hydrochloric Acid	(HCl)	0.5 M Copper (II) nitrate	(Cu(NO <sub>3</sub> ) <sub>2</sub> )
0.5 M Strontium nitrate	(Sr(NO <sub>3</sub> ) <sub>2</sub> )	0.5 M Sodium and Potassium Nitrate	(Na <sup>+</sup> , K <sup>+</sup> )
0.5 M Barium nitrate	(Ba(NO <sub>3</sub> ) <sub>2</sub> )	solid sodium chloride	
0.5 M Sodium chloride	(NaCl)	unknown solutions	
0.5 M Calcium nitrate	(Ca(NO <sub>3</sub> ) <sub>2</sub> )	distilled water	
0.5 M Lithium nitrate	(LiNO <sub>3</sub> )	Platinum (Nichrome) wire	
0.5 M Sodium nitrate	(NaNO <sub>3</sub> )		

### Procedure:

1. Thoroughly clean a 4 X 3 well plate. Rinse with distilled water and dry.
2. Put 5 drops of 6.0 M hydrochloric acid in several of the wells of the plate. Clean the wire by dipping it first in the HCl well and then holding it in the colorless flame of the burner. Repeat until the wire imparts no color to the flame.
3. Thoroughly clean a watch glass. Rinse with distilled water and dry.
4. Place a few drops of the barium nitrate solution on the edge of the watch glass.

5. Place the watch glass at the base of the Bunsen burner, near the air intake.
6. Heat the wire until it glows red, quickly place the hot wire into the drops of solution. Observe the color of the flame and record it in the data table.
7. Clean the wire as before using a new well of HCl.
8. Repeat steps 4-7 with the nitrates of Lithium, Strontium, Calcium, Sodium, Potassium, and Copper. Be sure not to allow the drops to mix on the watch glass, rinse it off if necessary.
9. If two metals are present in the same solution, the color of one metal's flame may overpower the other metal's flame. If the flame is observed under cobalt glass, the glass can sometimes absorb the overpowering flame's color so the other color can be seen. Observe the color of Sodium ions in the flame while looking at it through cobalt glass. Record the color you see in the data table. Repeat for Potassium ions.
10. Flame-test a mixture of the solutions of Potassium and Sodium and write down the color that you see. Now repeat this while observing the color through the cobalt glass and record your observations.
12. Clean the wire and test a solution as above of **sodium chloride**. Record your observations.
13. Place a few crystals of *solid* sodium chloride in an empty well. Dip the wire into the crystals and then hold the wire in the flame. Record your observations.
14. Obtain the unknown. Test it in the flame as you did with the known solutions. Record your observations.
15. Rinse off the well plate and watch glass in the sink and return them to where you got them.

#### DataTable

Metallic Ion Flamed	Color Seen in Flame
Strontium ( $\text{Sr}^{2+}$ )	
Barium ( $\text{Ba}^{2+}$ )	
Sodium ( $\text{Na}^+$ )	
Potassium ( $\text{K}^+$ )	
Lithium ( $\text{Li}^+$ )	
Copper ( $\text{Cu}^{2+}$ )	
Calcium ( $\text{Ca}^{2+}$ )	
Sodium Ion Through Cobalt Glass	
Potassium Ion Through Cobalt Glass	
Sodium and Potassium Ions Mixed	
Sodium and Potassium Ions Through Cobalt Glass	
Sodium Chloride Solution	
Sodium Chloride Solid	

**Post- Lab Questions:**

1. Is the flame coloration test a test for the metallic cation or the nitrate anion?
2. Do the dry sodium chloride and the solutions of sodium nitrate and sodium chloride all impart the same color to the flame? Explain your answer.
3. How would you characterize the flame test with respect to its sensitivity? Explain your answer.
4. What are some difficulties with the flame test that you encountered?
5. Explain what is taking place when both sodium and potassium ions are present on the wire when it is flamed. Make sure to include your observations recorded during the experiment. (See steps 9 and 10).
6. Over time, the labels from three bottles of chemicals faded until a scientist was not able to tell which label was which. The unlabeled bottles were known to contain: strontium nitrate, ammonium carbonate, and potassium sulfate. **Explain** how you could easily re-label the bottles. Make sure to include observations in your answer.
7. Describe the activity of an atom's electrons when a substance is vaporized in a flame and how that relates to the color of the flame. What would be viewed through a spectroscope during flaming if one was used during this lab, and how does this instrument serve to identify different substances?